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PRELIMINARY

MODEL 570 SERIES
MICROWAVE SWEPT OSCILLATORS

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E-H RESEARCH LABORATORIES, INC.
163 ADELINE STREET · OAKLAND, CALIFORNIA 94607

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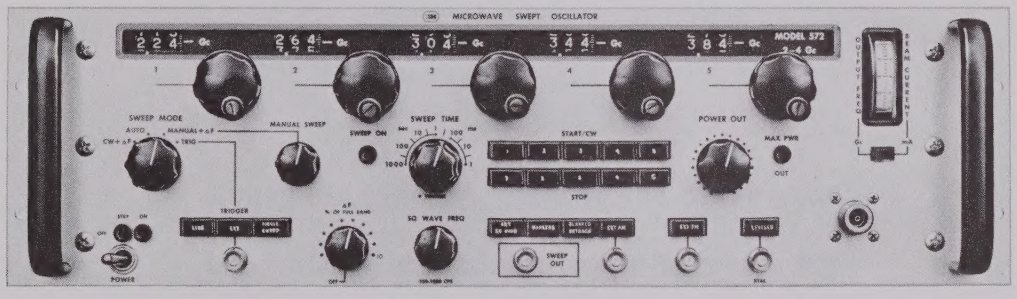

E-H RESEARCH LABORATORIES, INC.

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IMPORTANT

PERIODIC MAINTENANCE

To ensure adequate airflow in the Model 570, remove and clean the air-filter periodically. Wash with warm water and detergent, dry thoroughly, coat with an air-filter oil, and re-install.

Every six months, remove the cover panels and, with a low-pressure air-stream, blow away any accumulated dust.

FOREWORD

Units, abbreviations and prefixes of the International System of Units (SI) are used in this manual. Discrepancies may be noted between the terms used in the text and the instrument panel markings (e. g. ; hertz, kilohertz, megahertz for cps, kilocycles, megacycles, etc.)

The National Bureau of Standards announced its approval of the SI in February 1964, and subsequently the document was adopted by Congress as a national standard.

SECTION 1
CHARACTERISTICS

1-1 GENERAL

FREQUENCY CONTROLS

The E-H 570 Series Microwave Swept Oscillators are the most versatile and powerful high-accuracy sweepers available. All sweep limits and marker frequencies are incorporated into five 3-digit dials which are presetable and adjustable through the entire bandwidth of the instrument. Sweep direction and start-stop, CW, and marker frequencies are selected with pushbuttons corresponding to each frequency control dial. Those dial settings not selected as start-stop frequencies automatically become markers. During any sequence of selection of start-stop pushbuttons, all original frequency settings remain in the same condition until reset by the operator. The sweep direction may be up or down in frequency, depending on which of the two desired sweep frequency limits is selected as Start and which as Stop. For CW operation, any of the five control settings may be selected as the CW frequency.

A separate, calibrated ΔF control allows a symmetrical sweep up to 10% of the full band to be superimposed on any CW frequency without disturbing any of the frequency controls. The frequency controls are accurate to better than 1% at any frequency and at any output power level in any of these functions.

SWEPT OPERATION

The Model 570 Series sweepers have four operational modes: Auto, CW, Manual, and Triggered.

For wide-band sweeps, the AUTO or TRIG modes are used. For narrow sweeps, the ΔF control provides a symmetrical sweep up to 10% of the total bandwidth of the instrument centered on the manual sweep frequency or any one of the five CW frequencies.

In the AUTO mode, output frequency is recurrently swept from the START/CW to the STOP frequency by the internal sweep generator in 1000 seconds to 1 millisecond as set by the SWEEP TIME controls.

In the TRIG mode, operation is similar except that a trigger signal is required to initiate each sweep. Three TRIGGER pushbutton switches select the trigger sources: LINE, EXT, and SINGLE SWEEP. For LINE triggering, the sweep generator is internally triggered at the power line frequency. The sweep time and trigger controls are separate, so that the LINE trigger may be used with any sweep time. Trigger signals received during a sweep are disregarded.

EXTERNAL triggering requires a +4 volt signal (of at least one (1) microsecond duration) at either the front or rear panel TRIGGER INPUT connectors. The single sweep function triggers the sweep each time the SINGLE SWEEP pushbutton is depressed, and will continue to trigger as long as it is held down.

In the MANUAL mode, a CW output frequency may be manually swept across the same band, from START/CW to STOP, by rotating the MANUAL SWEEP control clockwise. Manual sweep reduces recorder set-up time to a matter of seconds.

In the CW mode, the single-frequency output is at the START/CW frequency, and is independent of the STOP frequency setting. The five frequency controls may be preset, and any one of the five may be selected with the pushbutton START/CW selector switches.

The ΔF function is designed for narrow-band sweeps. In the MANUAL + ΔF mode, the MANUAL SWEEP control can be used to scan the start-stop band. The ΔF control can then be used to display the area around any area of interest. Or, ΔF may be switched on first and a narrow frequency window scanned across the start-stop band with the MANUAL SWEEP control, displaying one small fraction of the band at a time. This effectively magnifies the ΔF portion of the start-stop band to the full oscilloscope or recorder display size. Because ΔF is a separate control, none of the five frequency control settings need be disturbed during ΔF operation.

MARKERS

As the output signal frequency sweeps from the START/CW to the STOP frequency, markers are generated at the frequencies set on the other three frequency controls. Markers may be used to bracket a band of interest and then be selected as the new sweep limits for more detailed examination, without disturbing any frequency settings. The vee-shaped markers are large enough to be clearly visible with wide sweeps, yet narrow enough to give excellent resolution on extremely narrow sweeps.

SWEEP WAVEFORMS

Sweep time is continuously adjustable with the SWEEP TIME selector switch and vernier controls over the widest range available in a microwave swept oscillator: 1000 seconds to 1 millisecond. This permits making extremely precise, slowly swept measurements, or sweeping at very fast rates in sweep radar studies, for example. The sweep voltage sweeps from zero to +15 volts as the output frequency sweeps from start to stop, independent of the bandwidth or direction of the sweep. The sweep voltage waveform is shown in Figure 1-1a, and is available at the SWEEP OUT connector.

To allow other components in the swept measurement system (e. g., detectors, recorders) sufficient settling time, there are dwell times at the beginning and

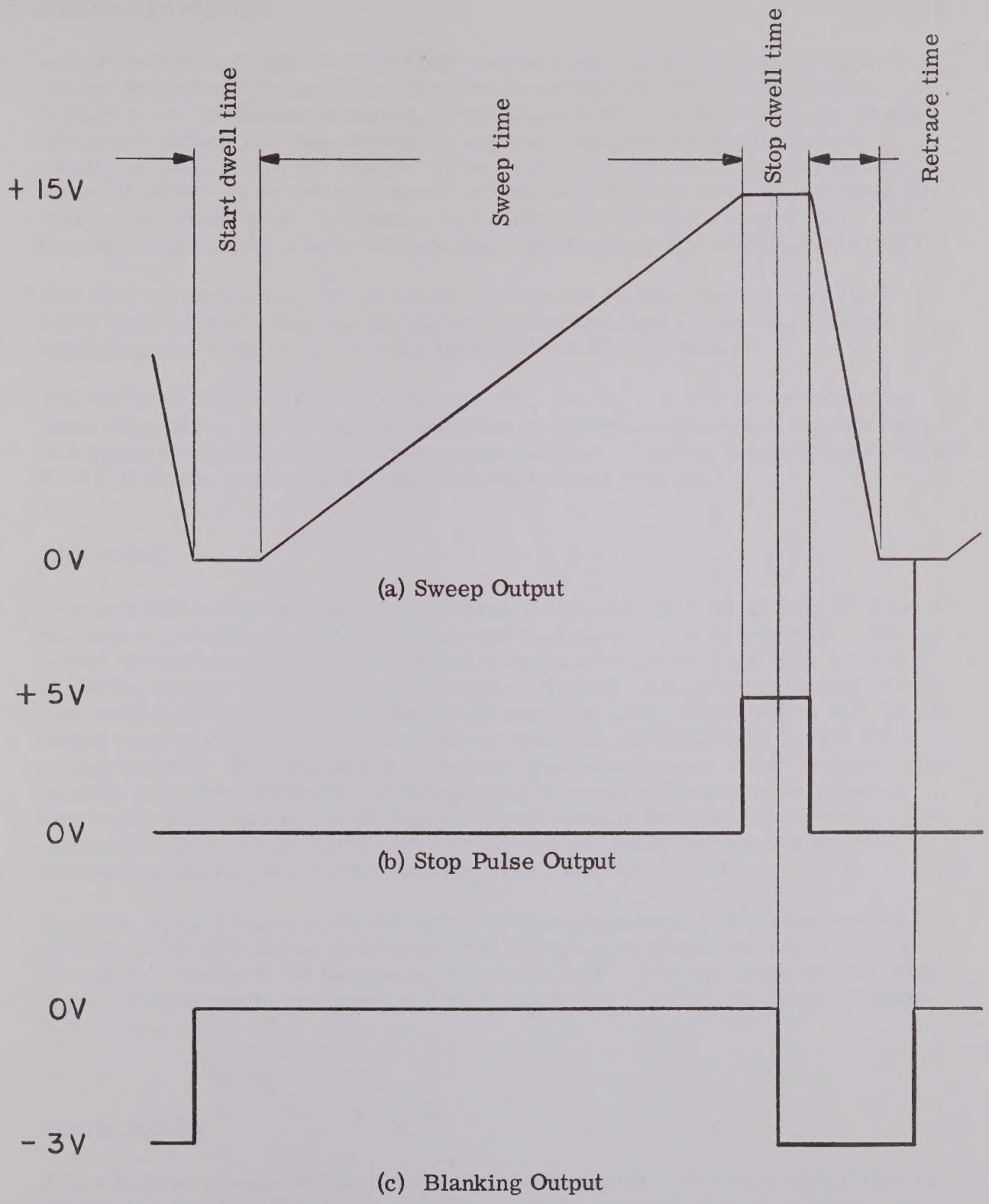

FIGURE 1-1 SWEEP WAVEFORMS

end of each sweep, and a controlled retrace time. Each is equal to approximately 10% of the sweep time. For the same reason, the blanking signal, Figure 1-1c, is phased as shown. The Blanked Retrace function cuts off the RF power during retrace, switching approximately at the dwell time midpoints, at each end of the sweep. This allows the system to settle before and after RF power is switched on or off at the ends of the sweep, eliminating the "fold-over" often seen when using other sweepers at fast sweep rates. The blanking signal is available for external blanking duty (BLANKING OUTPUT).

For X-Y recorder use, on the three slowest sweep time ranges, the PEN-LIFT terminals are shorted during the sweep and open during the retrace. Switching is synchronous with the BLANKING OUTPUT signal.

The STOP PULSE OUTPUT, (Figure 1-1b), provides a +5V pulse during the dwell time at the end of the sweep (at the stop frequency), which may be used to trigger another sweeper for two-band sweeps. Cascade triggering of several E-H 570 Series sweepers will provide multi-band sweeps.

LEVELING

The E-H 570 Series sweepers are designed for external closed-loop leveling at the load to provide the flattest power and best source match possible. The internal leveler amplifier holds leveled power variations to less than ± 0.1dB, excluding coupler and detector variations. Leveler amplifier is designed to be used with a 20 dB coupler (10 dB for Models 576 and 577) and either a negative-output crystal detector or a microwave power meter (PRD 686, or HP 431B, or equivalent). Because of the slow response time, power meter leveling may be used only with compatible sweep times, typically 30 seconds or greater. For applications where the best possible leveling is not needed, or where elimination of external components is a requirement, optional internal leveling is available at extra cost in Models 571, 572, 573, 574, 574-1.

Internal, open-loop leveling through anode programming is a feature in all models of the 570 Series and holds total variation in maximum output power across the band at 6 dB maximum, typically 3 dB. In many applications, this degree of flatness is sufficient and eliminates the need for additional leveling components.

MODULATION

A new high in versatility is provided by the pushbutton-selected modulation capabilities of the E-H 570 Series. External FM, with a bandwidth of dc to 100 kHz , may be superimposed on any internally-swept or CW mode. This allows anything from voltage programming the CW output frequency to complex frequency modulation of a swept output frequency.

Any or all of the four amplitude modulation functions may be performed simultaneously. The internal square-wave provides 100% amplitude-modulation of the power level set by the POWER OUT control. The square-wave frequency is variable from 950 to 1050 Hz, and once set, has excellent frequency stability. The markers amplitude-modulate the RF output only if the MARKERS button is depressed. RF power is cut off during retrace of the internally generated sweep if the BLANKED RETRACE is depressed (see Figure 1-1 for phasing). External AM provides the capability of performing any other AM functions from voltage programming of level to complex high-frequency modulation. Operation here is not restricted to levels below the POWER OUT setting: positive voltage increases output power; negative voltage decreases it; -10 volts completely cuts it off.

GRID MODULATION WITH LOW INCIDENTAL FM

One approach to minimizing the frequency pushing inherent in amplitude modulation of a BWO (up to 5-7% frequency shift from zero to maximum power) has been to perform the modulation external to the BWO with an electronically variable attenuator (absorptive modulator). But the widely used PIN-diode modulators have several shortcomings: Cost; minimum insertion loss of 1 dB to 4 dB, reduced available power; and limited dynamic range -- 20 dB to 25 dB below rated output power -- which result in an inadequate on-off ratio in many AM applications, especially when operating at less than rated power. Moreover, they fail to "virtually eliminate" incidental FM (FM due to AM) when operating into a mismatched load because of variation of masking of mismatched load by the modulator.

To overcome these difficulties, yet provide high frequency accuracy and low incidental FM, all E-H 570 Series sweepers use BWO grid amplitude modulation which incorporates feedback compensation for BWO frequency pushing. This reduces incidental FM an order of magnitude to typically 0.25% total frequency variation from zero to maximum power out. Thus, frequency dial accuracy is specified better than 1% for every dial, in any sweep mode, at any frequency, and at any output power level. At the same time, elimination of modulator insertion loss contributes to the very high maximum power out specification of these units, and true 100% amplitude modulation with low incidental FM is possible. No other microwave swept oscillator offers this combination of high power, high frequency accuracy, and low incidental FM. And in the bands above 12.4 GHz, where PIN-diode modulators are not available, the E-H 570 Series is unique in providing high accuracy and low incidental FM.

OTHER FEATURES

A switch-controlled front-panel meter reads either BWO beam current or the RF output frequency -- a convenience with manual sweeps or slow, internally generated sweeps. A rear-panel reference output is provided for external monitoring

of the output frequency.

A front-panel light turns on when all available BWO power is being delivered. If this light is on during leveled operation, it indicates that leveling is being attempted at higher power than the BWO can deliver. For leveled operation, the setting of the Power Out control must be below the point where this first occurs.

A three-position POWER switch and time delay circuit ensure that power is applied to the BWO in the proper sequence and after the proper warm-up time. The STBY position of the switch cuts off the RF output power while keeping the tube warmed up for immediate return to full operation in the ON position. If an E-H sweeper is turned off momentarily and then back on, return to full operation occurs in about twice the off time -- it is not necessary to wait the full cold-start warm-up time.

CONSTRUCTION, RELIABILITY

Operation of this compact, highly versatile sweeper is simplified by its human-engineered panel layout. Logical sequence of groups of controls and connectors of similar function enables the technician to master quickly the many facets of the operation of the instrument.

Internal layout is clean and serviceable. Six plug-in printed circuit boards contain the solid state low-voltage control circuitry. Low total power dissipation -- approximately 200 watts -- plus a powerful blower, keep the operating temperature of the generously derated circuitry low, ensuring maximum reliability.

1-2 SPECIFICATIONS

FREQUENCY CONTROLS	Five independent controls with 3-digit readout, each continuously adjustable over the entire frequency range.
FREQUENCY ACCURACY	<1% at any output power level.
SWEEP MODES	CW + ΔF: Single-frequency output at START/CW frequency selected by pushbutton. Any of the 5 frequency dials may be selected. ΔF sweep may be superimposed. AUTO: Sweeps from START/CW frequency to STOP frequency selected by pushbutton switch. Any of the 5 frequency dials may be selected as START/CW or STOP. Sweep recurs automatically.

MANUAL + ΔF: Front panel control varies the output frequency from START/CW to STOP frequency. ΔF sweep may be superimposed.

TRIG: Trigger initiates sweep from START/CW to STOP frequency.

Line: Internally triggered, synchronous with power line frequency.

Ext: Triggered by externally applied signal >+4V, >1 μs pulse width.

Single Sweep: Pushbutton initiates sweep.

ΔF SWEEP

Sweeps from lower to higher frequency, centered on CW or MANUAL SWEEP setting. Disabled with control fully counterclockwise (OFF position).

Width: Continuously adjustable from zero to 10% of the frequency band.

Width Accuracy: 10% of ΔF being swept ±1.0% of bandwidth of instrument.

Center Frequency Accuracy: <1% at any power level.

FREQUENCY MARKERS

Up to 5 frequency markers are available. Marker frequencies are determined by those frequency controls not selected as START/CW or STOP. Markers amplitude modulate RF output when front panel MARKERS pushbutton is depressed.

Accuracy: <1% at any power level.

Resolution: <0.05% at any frequency.

Marker Output: +1.0V triangular pulse from 500Ω source impedance at rear panel connector.

RESIDUAL AM

At least 40 dB below rated CW output.

SPURIOUS SIGNALS

Harmonics at least 20 dB below CW output; nonharmonics at least 40 dB below rated CW output.

SWEEP TIME

Continuously adjustable in 6 decade ranges, 0.001 to 1000 seconds. Controlled retrace time and

SWEEP TIME (Contd.)	.dwell times at beginning and end of sweep each approximately equal to 10% of sweep time.
SWEEP OUTPUT	Zero to +15V concurrent with swept RF output. Output impedance less than 100Ω in series with 20 μH.
REFERENCE OUTPUT	Direct-coupled voltage proportional to RF output frequency. Zero at low end of band, -20V at high end. Output impedance, 4KΩ.
FREQUENCY LINEARITY	<1%.
BLANKING	Switching occurs at approximate mid-point of dwell times at ends of sweep. Blanking Output: 0 V during sweep, -3V during retrace. Blanked Retrace: Front panel pushbutton switch for reducing output power to zero during retrace. Pen Lift: Terminals shorted during sweep, open during retrace on three slowest sweep time ranges.
STOP PULSE	+5V during dwell time at end of sweep; zero otherwise. Output impedance 1KΩ. Can trigger another sweeper to obtain very broad band sweeps.
POWER LEVELING AMPLIFIER	Internal direct-coupled leveling amplifier provided. Crystal Input: Leveler loop is designed for 20 dB coupler (10 dB with 576 and 577) and negative polarity crystal detector. Leveled power variation specification applies for sweep rates up to 10% of full band per millisecond. Power Meter Input: 1000Ω input resistance and leveler amplifier gain shaping designed for 20 dB coupler (10 dB with 576 and 577) and H-P 431B or PRD 686 power meter or equivalent. Sweep rate must be compatible with response time of power meter.
POWER VARIATION, UNLEVELED	Less than 6 dB over the entire band at maximum power out.

POWER VARIATION, EXTERNAL LEVELING	± 0.1 dB ± coupler and detector variations at rated output power.
EQUIVALENT SOURCE MATCH	Externally leveled: Depends on coupler. Unleveled: Less than 2.5:1.
MODULATION	Internal square wave AM: 100% modulation continuously adjustable in frequency from 950 to 1050 Hz with frequency stability of $< 0.05\%$ per minute after one minute warm-up. External AM: Frequency Response: dc to 1 MHz unleveled, dc to 50 kHz leveled. Sensitivity: 10V for 100% modulation; -10V at any power setting reduces output power to zero. Polarity: positive voltage increases output power. External FM: Frequency Response; dc to 100 kHz. Sensitivity: deviation from internally generated frequency, 5% of band per volt. Maximum Range: full band for modulation frequency up to 1 kHz (20V peak-to-peak input) decreasing to about 1% of full band at 100 kHz. Input Impedance: $4k\Omega \pm 2\%$.
METER ACCURACY	Output Frequency: ± 4% of total bandwidth of the instrument. Beam Current: ± 6% of full scale.
FREQUENCY STABILITY	With Temperature: $0.01\%/^{o}C$. With 10% Line Voltage Change: 0.01%. With Power Level Change: Frequency accuracy specification is maintained. Residual FM: Less than 10 ppm peak, referred to the total bandwidth of the instrument. (See Table Following).
POWER	105 to 130V, 50/60 Hz; 230V optional. Approximately 200 volt-amperes.

DIMENSIONS	5-1/4" x 19" x 19".
WEIGHT	55 lbs. or less.
INSTALLATION	The sweeper must be operated so that the BWO is at least 4 inches from any ferromagnetic materials or strong magnetic fields.

Model	571	572	573	574	574-1	575	576	577
Freq Range (GHz)	1-2	2-4	4-8	8.0-12.4	7.0-12.4	12.4-18	18-26.5	26.5-40
Max Pwr Out (mW) (Leveled or Unleveled)	>120	>90	>35	>50	>30	>48	>12	>6
Residual FM (Peak)	< 10kHz	< 20kHz	< 40kHz	< 44kHz	< 54kHz	< 56kHz	< 85kHz	< 135kHz
Output Impedance	50 Ω	50 Ω	50 Ω	50 Ω	50 Ω	--	--	--
Output Connector	Type N	Type N	Type N	Type N	Type N	UG-419/U	UG-595/U	UG-599/U
Price	$3660	$3460	$3460	$3580	$3760	$3730	$4570	$6870

SECTION 2
OPERATING INFORMATION

2-1 UNPACKING

Immediately after unpacking the instrument, carefully inspect and evaluate the condition of the shipping container and instrument for evidence of damage that might have occurred during shipment or handling. If damage is noted, the responsible carrier or agency should be promptly notified.

2-2 POWER

Input power receptacle is a 3-prong recessed standard male connector on the rear panel. Requirements are 105 to 130v, 50/60 Hz, approximately 200 volt-amperes.

2-3 MOUNTING

The 570 Series is designed for either bench or rack application. When setting up, be certain that the air intake and the exhaust vents are at no time impeded.

2-4 BWO LIFE

The backward-wave oscillator (BWO) tube used as the RF source in the Swept Oscillator, is warranted by the BWO manufacturer against failure for a limited period of time, usually 2500 hours of filament operation. An elapsed-time meter, 5000 hours full-scale, is incorporated in the 570 Series Sweepers to monitor BWO filament hours. It is mounted on the low-voltage rectifier board which is accessible when the bottom cover is removed.

To maximize BWO tube life:

(1) Provide adequate ventilation around the instrument by allowing at least three inch clearance at the intake and exhaust ports.

(2) Keep the air filter clean so air flow is not restricted.

(3) Avoid prolonged operation in STBY mode, which keeps BWO filament and elapsed time meter running.

2-5 FRONT PANEL OPERATING CONTROLS AND CONNECTORS

Table 2-1 contains a list of front panel operating controls, along with the function of each.

2-6 REAR PANEL OPERATING CONTROLS AND CONNECTORS

Table 2-2 contains a list of rear panel operating controls, along with the function of each.

2-7 OPERATION

Power Switch: The toggle switch in the lower left-hand corner of the front panel has three positions. The far left position is OFF. The center position is STANDBY, and applies only heater and grid voltages to the BWO, but completely activates the sweep generator circuit. The extreme right ON position applies power to all elements of the BWO so that RF power can be delivered at the OUTPUT connector. There is an electronic delay when switching ON from a cold start, for BWO protection so that 40 to 60 seconds must elapse in the STANDBY mode before the instrument switches ON. The indicator lamps over the respective switch positions show whether the instrument is in the STANDBY or ON mode. In switching rapidly from STANDBY or ON to the OFF position and back, a time interval approximately equal to twice that of the OFF time must pass before the instrument may return to the ON mode.

After the original delay time has elapsed, the instrument can be held in the STANDBY mode and switched ON with no delay.

Sweep Mode: The sweep mode selection is located to the far left of the front instrument panel.

CW + Δ F: In this position the sweeper produces a CW output of the frequency displayed by the selected digital frequency dial. Any one of the five dials may be selected by depressing the corresponding START/CW pushbutton. In this mode the knob designated Δ F can be rotated clockwise to switch on the internal sweep generator and superimpose a symmetrical sweep of up to 10% of the total bandwidth of the instrument. The SWEEP ON light indicates that the internal sweep generator is ON and ΔF is being applied. For cleanest CW only operation, the ΔF knob should be rotated fully counterclockwise to its OFF position.

Auto: In the automatic sweep mode, the instrument continuously sweeps from a START frequency to a STOP frequency designated by the digital dial settings of those two dials which correspond to the two pushbutton switches depressed respectively on the START and the STOP rows of buttons centrally located on the front control panel. The sweep will start at the frequency set on the digital dial

selected as START on the pushbutton tier, and will stop at the digital dial reading designated by the button pushed on the STOP frequency tier, irrespective of the values of those frequencies and irrespective of changes in the dial reading produced by adjusting the digital dials.

Thus, the sweep will track the START and STOP frequencies as they cross back and forth past each other. During any sweep where any of the remaining three unselected digital dial frequencies lie between the start and stop frequencies, and where the MARKERS button is depressed on the amplitude modulation button tier, markers comprising a triangular signal of constant amplitude will appear at those frequencies.

Manual + ΔF: In this position of sweep mode, the MANUAL SWEEP knob changes the frequency from the START to the STOP designations on the START/CW-STOP pushbutton tiers as it is manually turned clockwise. In this mode, the SWEEP ON indicator light will be OFF. The ΔF can then be applied to the manual sweep, which superimposes a symmetrical sweep up to 10% of the full band on it.

The SWEEP ON indicator light will be on during ΔF sweep.

Trig: In the triggered mode the generator sweeps from the START frequency to the STOP frequency and retraces each time it receives a proper trigger signal. Trigger signals received during the sweep are disregarded. The trigger source is selected by one of the three trigger pushbuttons. Pushbutton selection of LINE will supply the trigger pulses at the line frequency rate. Depressing the nonlatching SINGLE SWEEP button will trigger the sweep. Selection of the EXT pushbutton permits triggering with an external pulse applied to the BNC connector directly below it. The pulse must be at least 4 volts positive for 1μs or more. Input impedance is 10kΩ nominal, 3kΩ minimum. A trigger input connector identical in operation to that on the front panel is available on the back panel.

Internal Sweep Pattern: (See Figure 1-1) With the internal sweep generator running, the SWEEP OUT waveform is a saw-tooth waveform sweeping from 0 to +15v at a sweep time continuously variable from 0.001 to 1000 seconds. There is a CW dwell time at the beginning and end of each sweep (at the START and STOP frequencies, respectively), with a duration of 10% of the sweep time. This dwell time allows time for peripheral equipment (e.g., X-Y recorder), with response time compatible with the selected sweep time, to respond fully to rapid changes, such as blanking and retrace. Also, in the case of the STOP frequency dwell time, the beginning and the end of the dwell time coincides with the beginning and the end of a stop pulse which appears as a +5v signal at the BNC connector marked STOP PULSE on the rear instrument panel.

The sweep signal is available at all times regardless of SWEEP MODE switch setting, and when POWER switch is on either the STBY or the ON position.

The output is at the BNC output connector marked SWEEP OUT at the lower center of the front panel.

Modulation: The amplitude modulation controls comprise four pushbutton positions

near the lower center part of the front control panel. The left-hand pushbutton actuates the internal square wave amplitude modulation circuit which produces 100% square wave amplitude modulation of the output power with frequency adjustable from 950 to 1050 Hz by turning the square wave frequency knob located to the left of the internal square wave pushbutton.

The pushbutton labeled MARKERS produces a triangular negative signal at the frequency setting of each dial not selected as a START or STOP frequency. The marker signal of +1v is available at the back panel output BNC connector labeled MARKER OUTPUT regardless of the position of the MARKERS button on the front panel.

The selector button adjacent to the right of the MARKERS button is the BLANKED RETRACE selector, which drops the output power to zero during the retrace portion of the sweep. (See Figure 1-1). On a crystal detector oscilloscope display, the trace will show a flat return line at zero volts with a high intensity spot at each end, representing one-half of the dwell time at the STOP and START frequency. The blanking signal of -3v is available regardless of the position of the button marked BLANKED RETRACE on the front panel at the BLANKING OUTPUT BNC connector on the back panel.

The last button on the right of the amplitude modulation pushbutton tier is the EXT AM button which connects the BNC connector directly beneath it to the BWO grid modulation circuit.

The generator can be amplitude-modulated with an external signal of 10v for 100% modulation and a frequency response from DC to 1 MHz unleveled. The modulation signal is coupled to the BWO control grid circuit with a positive voltage providing an increase in output power.

The pushbutton marked EXT FM, which is the second button from the right at the bottom of the instrument panel, connects the BNC connector directly below it to the helix modulation circuit. The RF output signal can be frequency-modulated from DC to 100 kHz with a sensitivity of 5% of full band deviation per volt. Maximum allowable deviation is 100% of the full band up to 1 kHz, decreasing to 1% at 100 kHz. The input impedance for EXT FM is 4kΩ ± 2%. To avoid damage to the instrument, EXT FM signal must be limited to voltages which will keep the output frequency within the specified band of the instrument plus a 10% overrange.

Leveling: Closed-loop leveling with an external coupler and detector is enabled by pushing the LEVELED button at the lower right-hand area of the front panel adjacent to the power output connector, and by selecting the desired leveling mode on the slide switch at the rear panel marked XTAL or PWR MTR. At the XTAL switch position, the front panel BNC connector directly beneath the LEVELED button will accept a negative crystal detector output and connects to the internal leveler amplifier which provides a correction signal to the grid circuit of the BWO, leveling power to ± .1 dB, excluding coupler and detector variations.

Power meter leveling is available by selecting the PWR MTR position on the level detector slide switch on the rear panel, and by applying the recorder output signal from a microwave power meter (HP 431B, or PRD 686, or equivalent) to the BNC connector directly below the rear panel level detector selector switch. The LEVELED button on the front panel must be depressed in either leveled mode. Connect only the one level detector being used. A 20 dB directional coupler must be used (10 dB with 576 and 577).

Power Out: The knob control adjacent to the right of the START/CW-STOP pushbutton tier is the POWER OUT control. It controls the voltage on the BWO control grid. The MAX PWR OUT indicator light indicates the point where the control grid voltage is zero, which is full power. During leveled power operation, this light must be out.

Reference Output: A direct-coupled voltage proportional to microwave output frequency is available at the BNC output connector marked REFERENCE on the REAR panel. The voltage range is zero at the low frequency end and -20v at the high frequency end, with an output impedance of 4kΩ. The REFERENCE signal also drives the vertically-mounted edgewise meter on the front panel when the meter switch is in the OUTPUT FREQ position.

All controls are designed to prevent harm to the instrument in the event of unspecified combinations of control settings.

2-8 RF POWER LEVELING

Although the power variation of the BWO as a function of frequency has been minimized by anode programming (3 dB total variation, typically), in critical applications better flatness is desirable. This is achieved by closed-loop leveling, which senses variations in output power and feeds back a correcting signal to the amplitude-modulation control.

The 570 series includes a built-in high-gain dc leveler amplifier designed for closed-loop external leveling with a 20 dB directional coupler (10 dB for 576 and 577) and a detector. This allows power to be leveled at any point in the system, eliminating power variations introduced by the transmission system from the sweeper to that point.

With fast sweep times (<30 sec for full-band sweep), crystal leveling should be used. Connect a flat-response negative-output point-contact crystal detector to the coupled arm of the directional coupler inserted in the system at the point where leveled output power is desired. Connect a shielded cable -- as short as possible and no longer than 10 feet -- from the crystal output to the XTAL connector under the LEVELED pushbutton. To minimize hum pickup, route this cable as close as possible to the RF output transmission system. Be sure the rear-panel LEVEL DETECTOR switch is in the XTAL position. Depress the LEVELED pushbutton. Now leveled power will be delivered to the

load at the level set by the POWER OUT control, adjustable from zero to the maximum power available from the BWO. When leveling, the MAX PWR OUT lamp must remain off. This lamp comes on if POWER OUT control is set too high for leveling across the selected frequency range.

With slow sweeps where an X-Y recorder display is preferred, a thermister-mount power meter may be used as the level detector (HP 431B, or PRD 686, or equivalent). Connect the thermister mount to the coupled arm of the leveler directional coupler. Connect the power meter's recorder output to the rear-panel PWR MTR input connector directly under the LEVEL DETECTOR switch, which must be in the PWR MTR position. Depress the leveled pushbutton. Leveled power will be delivered to the load. Here the POWER OUT control adjusts output power from zero to full scale of the selected power meter range. With the POWER OUT control set, the power meter range switch acts as a stepped attenuator, 5 dB per step. This effectively converts the swept oscillator to a swept signal generator. Remembering the coupling factor of the directional coupler, do not use power meter ranges above the lowest one which includes the maximum power specification of the instrument. This slows the response time of the leveling system and increases the sensitivity of the POWER OUT control.

When power meter leveling on the most sensitive power ranges, occasionally a relaxation oscillation is started in the leveling loop when power is turned ON. When this happens, the power meter reading cycles from zero to full scale at approximately one hertz. To stabilize the system, turn the POWER OUT control fully clockwise, or turn the range switch up one or two ranges until the system settles. Then return to the desired setting. To avoid the power switching transients introduced thereby, do not use the BLANKED RETRACE when power meter leveling. When power meter leveling, the LEVEL DETECTOR switch must be in the PWR MTR position, the power meter recorder output must be connected to the rear-panel PWR MTR connector, the front-panel XTAL connector must be open, and the LEVELED pushbutton must be depressed.

When crystal leveling, the LEVEL DETECTOR switch must be in the XTAL position, the crystal output must be connected to the front-panel XTAL connector, the rear-panel PWR MTR connector must be open, and the LEVELED pushbutton must be depressed.

The maximum output power specification applies to leveled as well as unleveled power, delivered at the front-panel RF OUTPUT connector. With external leveling, transmission loss between the OUTPUT connector and the leveler and load will reduce the leveled power available at the load.

For normal use, the leveler coupler and detector should have as flat frequency response as possible. For reflectometer use, the leveler coupler and detector need not be extremely flat, but should be matched to the reflectometer coupler and detector, and both couplers should have as high directivity as possible.

TABLE 2-1

FRONT PANEL OPERATING CONTROLS AND CONNECTORS

POWER	This three-position switch and associated indicator lights provide for STBY and full ON operation. In STBY condition filament voltage is applied to BWO; there is no RF output. In switching ON from a cold start, STBY operation occurs for a warmup period appropriate to the BWO used, then switches ON automatically.
FREQUENCY CONTROLS	These controls, numbered one through five, and their associated 3-digit readouts, may be set anywhere in the frequency band of the instrument, independent of the other settings. They determine all start, stop, CW, and marker frequencies.
START/CW	This set of five numbered pushbuttons selects one of the five frequency controls as the start frequency in any of the swept modes, or as the CW frequency in the CW mode.
STOP	This set of five numbered pushbuttons selects one of the five frequency controls as the stop frequency in any of the swept modes. In the CW mode it has no effect.
SWEEP MODE	This switch selects the CW mode or any of three swept modes. In AUTO, sweep from START to STOP frequency is recurrent, with the sweep time set by front panel controls. In MANUAL, with ΔF off, sweep from START to STOP is achieved by clockwise rotation of MANUAL SWEEP control. In TRIG, sweep from START to STOP occurs only if a trigger pulse is received after completion of previous sweep.
TRIGGER	These three pushbuttons select the trigger source for triggered operation. The interlocked and latching LINE and EXT buttons allow triggering at the power line frequency or triggering from an external 4 volt, 1 microsecond pulse. Depressing the momentary-contact SINGLE SWEEP button after completion of a sweep initiates a new sweep; sweep generator free runs if SINGLE SWEEP is held down.
MANUAL SWEEP	Clockwise rotation of this control sweeps output frequency from START to STOP and SWEEP OUT voltage from 0 to +15v.

Δ F	This control, when switched on, provides a recurrent symmetric sweep up to 10% of the full band centered on the normal CW output frequency in either the CW or MANUAL sweep modes. The sweep time is set by the front-panel SWEEP TIME controls and with ΔF ON, the SWEEP OUT voltage sweeps from 0 to +15v concurrent with swept Δ F.
SWEEP ON	This light is on during the sweep time of any of the internally swept modes: AUTO, TRIG, or ΔF. In the triggered mode, the light turns on as soon as the trigger has been received, but before the sweep actually starts.
SWEEP TIME	This switch and the concentric VERNIER provide sweep times from 0.001 to 1000 seconds in six overlapping decade ranges. Dwell times at the ends of the sweep and the controlled retrace time are each approximately 10% of whatever sweep time is selected.
SWEEP OUT	Provides a swept voltage from 0 to +15v as the output frequency sweeps from START to STOP in any of the swept modes. In CW with ΔF off, output is zero volts. With Δ F on in CW or MANUAL modes, output sweeps from 0 to +15v, synchronous with upward ΔF sweep.
INT SQ WAVE	When depressed, square-wave amplitude modulates the RF output 100% at a rate of 950 to 1050 Hz.
SQ WAVE FREQ	Selects rate of internal square-wave modulation from 950 to 1050 Hz.
MARKERS	When depressed, amplitude modulates the RF output at the marker frequencies. Marker frequencies are set by those frequency controls not selected as START/CW or STOP.
BLANKED RETRACE	When depressed, cuts off RF output power during the sweep retrace. Switching occurs at the approximate mid-points of the start and stop dwell times.
EXT AM	When depressed, allows amplitude modulation with an external signal applied to the associated connector. Bandwidth is dc to 1 MHz unleveled, and dc to 50 kHz crystal leveled.
EXT FM	When depressed, allows frequency modulation with an external signal applied to the associated connector. Modulation rates may be from dc to 100 kHz. External FM is

EXT FM (Contd.)	superimposed on whatever frequency the internal sweep generator provides.
POWER OUT	This control adjusts the RF output power from zero to the maximum available, in either leveled or unleveled operation.
MAX PWR OUT	This light turns on when the RF output is at the maximum available power level. In unleveled operation this corresponds to full clockwise rotation of the POWER OUT control. When leveling, the light turns on indicating unleveled operation if leveling is attempted at higher power than the maximum available. The POWER OUT control must be set to keep the lamp off during leveled operation.
LEVELED	When depressed, allows closed-loop external leveling at the load with a 20 dB directional coupler (10 dB for 576 and 577) and negative-output crystal detector or thermistor-mount power meter, whichever is selected by the rear-panel Level Detector switch. When crystal leveling, crystal detector output is connected to the associated XTAL connector.
METER	Can be switched to indicate either output frequency or beam (cathode) current of BWO in CW or slowly swept operation. For fast sweeps, average value is indicated.
RF OUTPUT	Type N female connector or waveguide and cover flange deliver RF output to the load.

TABLE 2-2

REAR PANEL OPERATING CONTROLS AND CONNECTORS

TRIGGER INPUT	This connector is wired in parallel with the front-panel trigger input connector for cabling convenience in system and cascade-sweeper applications.
STOP PULSE OUTPUT	Provides a +5 volt pulse during the STOP dwell. May be used to trigger a cascaded sweeper for multi-band sweeps.
BLANKING OUTPUT	Provides a -3 volt pulse during sweep retrace whether or not front-panel BLANKED RETRACE button is depressed. Switching to and from -3 volts occurs at approximate mid points of start and stop dwell times.
MARKER OUTPUT	Provides a +1 volt triangular pulse when output sweeps across a marker frequency whether or not front-panel MARKERS button is depressed.
REFERENCE OUTPUT	Provides an output voltage directly proportional to the instantaneous RF output frequency. Low end of the frequency band corresponds to 0 volts; high end, to -20 volts.
LEVEL DETECTOR	Selects XTAL or PWR MTR level detectors. The input connector for the power meter recorder output is directly below that position of the switch. The 1 kilohm termination necessary for proper power meter operation is built into the sweeper. The LEVEL DETECTOR must be in the position corresponding to the level detector used. Connect the level detector output to the proper input connector -- PWR MTR on rear panel and XTAL on front panel -- and leave the other connector open.
PEN LIFT	For X-Y recorder operation, these two terminals are shorted during the sweep and open during retrace on the three slowest sweep time ranges. Switching occurs synchronously with blanking.

WARRANTY CLAIM AND ADJUSTMENT PROCEDURE

for microwave tubes supplied by
E-H RESEARCH LABORATORIES, INC.
for use in E-H instruments

Service centers for E-H instruments are maintained throughout the world. When suspected microwave tube problems arise, do not hesitate to call on your local E-H or representative's office for service assistance.

The procedure described below is for use within the United States. For warranty claims arising outside the U.S.A., before returning the tube, fill out the service information form and send it with a request for shipping instructions to your local E-H office.

Microwave tubes supplied by E-H Research Laboratories, Inc., either as original or replacement, for use in E-H instruments are actually warranted by the tube manufacturer and not by E-H. However, E-H will process warranty claims for you, and will promptly pass on all allowances granted by the tube manufacturer.

In the event that your tube is found to be repairable, the tube manufacturer reserves the right to repair and return the tube in lieu of issuing pro-rata credit.

For your convenience, warranty claims for all microwave tubes supplied by E-H Research Laboratories, Inc. may be made on this single form; merely fill in the information requested and return this form, along with the defective tube, to your E-H field office or to the E-H factory. Please be sure each space on the form is filled in--lack of complete information may delay processing of your claim.

Each tube manufacturer has his own warranty policy. Copies of individual Conditions of Warranty are available from E-H Research Laboratories, Inc.

TUBE RETURN PROCEDURE

NO ALLOWANCE WILL BE MADE FOR RETURNED TUBES WHICH ARE BROKEN ON ARRIVAL AT THE FACTORY. TUBES MUST BE PACKED AND SHIPPED ACCORDING TO THE INSTRUCTIONS BELOW AND THE SERVICE INFORMATION FORM MUST BE PROPERLY COMPLETED AND INCLUDED IN THE TUBE CARTON.

1. Carefully wrap tube in ¼ inch thick "kimpack" cotton batting, or other soft padding material, or "skinpack" on cardboard diagonally fitted into container. Cable assemblies and other accessories not rigidly mounted to the tube should be padded and wrapped separately to prevent damage to the tube during shipment.

2. Wrap the above in heavy kraft paper.

3. Pack in a rigid container which is at least 4 inches larger than the tube in each dimension.

4. Surround the tube with at least 2 inches of packed excelsior or similar shock absorbing material. Be certain that the packing is tight all around the tube.

5. Tubes returned from outside the continental United States should be packaged in a wooden box.

6. Mark container fragile and ship prepaid via air freight or railway express to address shown on the opposite page. Do not ship via parcel post or air parcel post.

N O T E

Tubes with permanent magnets can interfere with magnetic compasses. For air shipment plainly mark container: "MAGNETIZED MATERIAL"

MICROWAVE TUBE WARRANTY CLAIM

SERVICE INFORMATION FORM

IMPORTANT: Please answer all questions fully -- insufficient information will delay processing of your claim. Note tube return procedure on reverse side.

DATE_____

FROM: (TUBE OWNER)

COMPANY_____

ADDRESS_____

_____

TUBE MANUFACTURER_____

_____

TUBE TYPE_____

TUBE SERIAL NO._____

TUBE IS ORIGINAL ( )

TUBE IS REPLACEMENT ( )

DATE TUBE RECEIVED_____

DATE FIRST TESTED_____

DATE PLACED IN SERVICE_____

FOR FURTHER INFORMATION CONTACT:

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

_____

E-H MODEL NO._____

INSTRUMENT SERIAL NO._____

EQUIPMENT PURCHASE DATE_____

HOURS USE PER DAY (average)_____

NUMBER OF DAYS IN SERVICE_____

ELAPSED-TIME METER READING_____

or ESTIMATED TOTAL FILAMENT HOURS_____

DATE OF FAILURE_____

SYMPTOMS: (Please describe conditions prior to and at time of failure, along with description of the tube's defect, if known.)

_____

_____

Please describe any other circuit component failures which occurred at the same time

_____

_____

SIGNATURE_____

TITLE_____

TUBES RETURNED TO E-H SHOULD BE ADDRESSED TO:

CUSTOMER SERVICE DEPARTMENT, E-H RESEARCH LABORATORIES, INC.

163 ADELINE STREET, OAKLAND, CALIFORNIA - Phone: TE 4-3030, Area Code 415

TWX: 910-336-7258

D-1970 A

REVISIONS							
ISSUE	REVISION	DATE	DRAWN	CHKD	APPVD	E.O.
A	ORIG RELEASE	4/30	RS			

BLANKING OUTPUT
+20V
0V
PEN LIFT
PEN LIFT CIRCUIT
TO BLANKING SWITCH, AM DECK
SWEEP OUT
SWEEP TIME SELECTOR 1ms-1000s
TRIGGER SELECTOR OFF AUTO LINE EXT SINGLE
X 3/4 ISOLATING AMPLIFIER
SWEEP MODE
AUTO
CW
MANUAL
TRIG
SWEEP
SWEEP GENERATOR
ΔF
INVERTER W.R.T.+10V
MARKER FREQ SETTINGS 1 2 3 4 5
DIAL SELECTOR SWITCHING
MANUAL SWEEP
+20V
CW
STOP FREQ
START FREQ
STOP FOLLOWER
START FOLLOWER
SUMMING AMPLIFIER
0 TO -20V
+1V
-1V
ΔF
EXT FM
REFERENCE OUTPUT
4.02K
OUTPUT FREQ METER
MARKER OUTPUT
+1V
0
0
-1V
MARKER GENERATOR
TO MARKER SWITCH, AM DECK
1 2 3 4 5 MARKER FREQ SETTINGS
UNREGULATED HIGH VOLTAGE
SWEEP AMPLIFIER
HIGH VOLTAGE REGULATOR
HELIX OVER-CURRENT DETECTOR
COLLECTOR
HELIX
HELIX RESISTOR STRING
BWO
RF OUTPUT
+400S
ANODE REGULATOR LO HI SLP
ANODE
GRID
FACTORY SELECTED
LEVELER AMPLIFIER BAL LO SLP
FPC
FILAMENT REGULATOR & FILAMENT OVERVOLTAGE DETECTOR
BEAM CURRENT METER
INT SQ WAVE
MARKERS
BLANKED RETRACE
AM
POWER OUT
EXT AM
LEVEL DETECTOR

PROPRIETARY INFORMATION
NO INFORMATION GIVEN HEREIN MAY BE DISSEMINATED TO ANY PERSON OR COMPANY WITHOUT THE EXPRESS PERMISSION OF E-H RESEARCH LABORATORIES, INC.

ITEM NO.	PART NO.	DESCRIPTION	QTY

MATERIAL LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
DECIMALS ± .XX ± .XXX
ANGLES ±
MACHINED SURFACES √
DO NOT SCALE DRAWING
FINISH

E-H RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA

TITLE: BLOCK DIAGRAM

MODEL	570
DRAWN	R. SCHNABEL 5/2/66
CHK'D	5/2/66
APP'D	5/2/66
SIZE	D-11970
REV	A

USED ON 570 | REQ'D 1 | NEXT ASSY